Plant Breeding
Past, Present, and Future

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Distant past

- 5,000 -10,000 years ago
  - Crop domesticators

Past

- ~10,000 → 200 years ago
- Farmer breeders

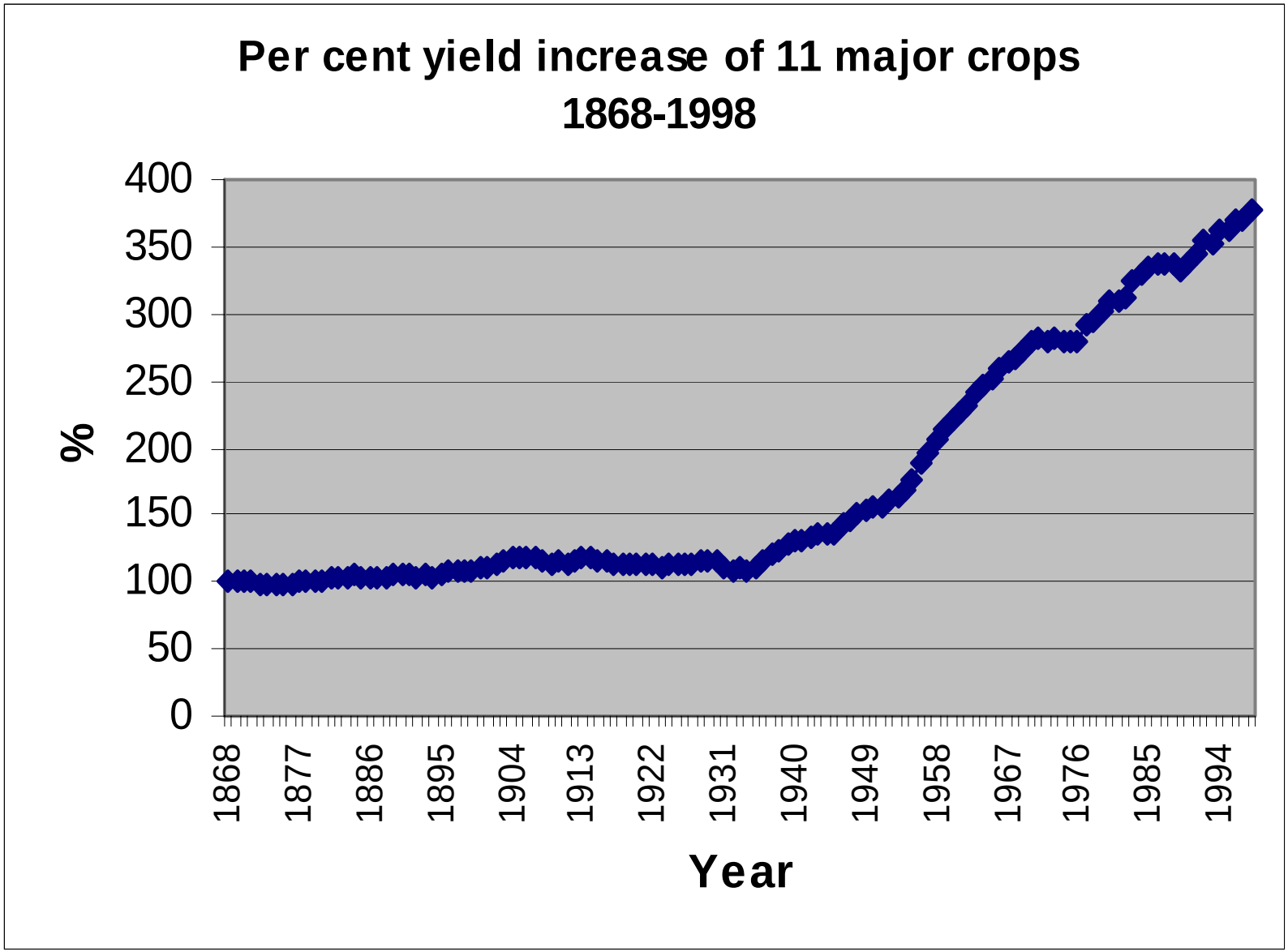
Recent past

- Late 1800's
- Scientific plant breeding
  - Genetics
  - Statistics
- Land Grant Universities

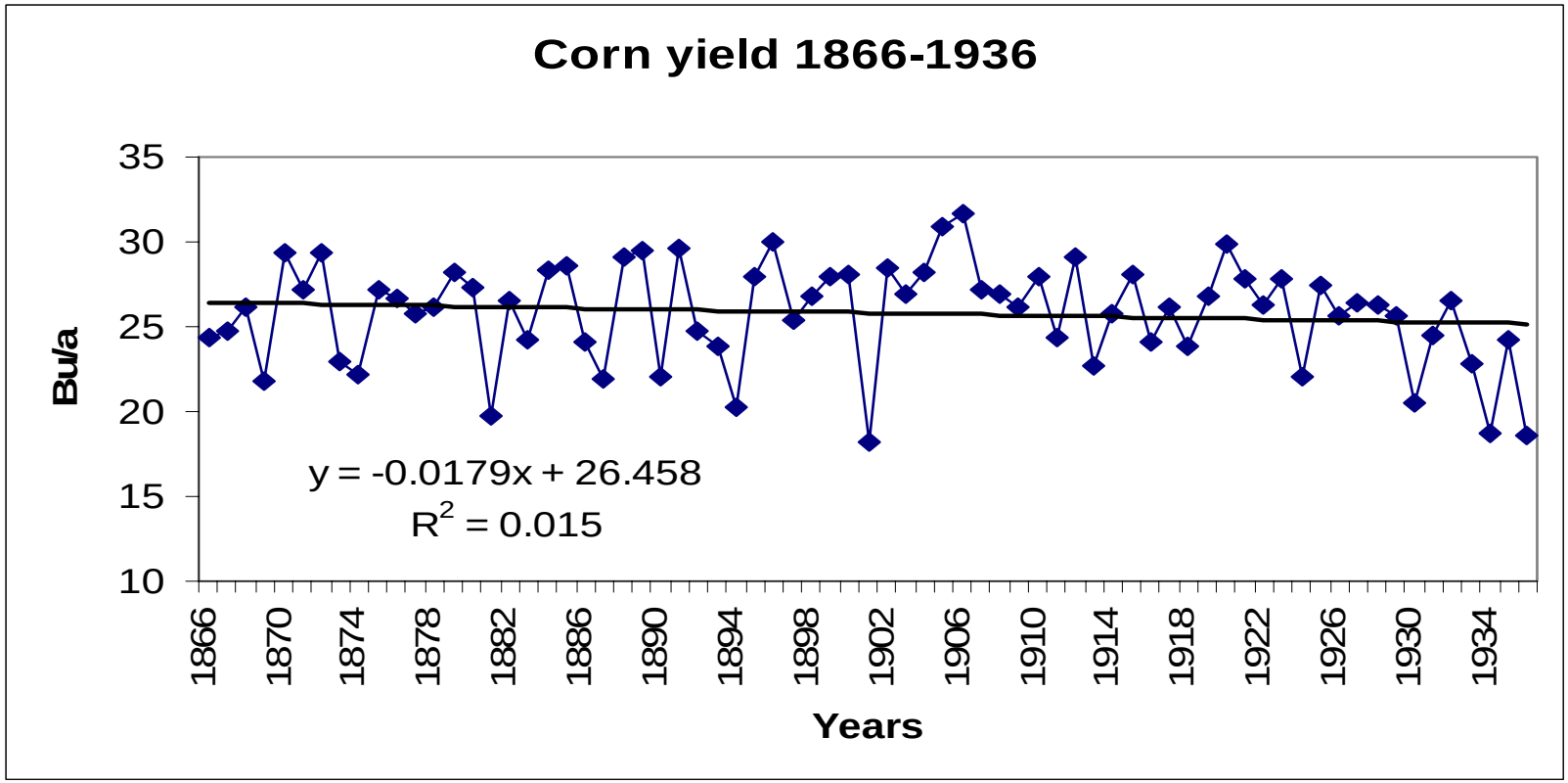
Recent past

- Late 1800's
- Scientific plant breeding
  - Genetics
  - Statistics
- Land Grant Universities
- Private companies

Recent Past

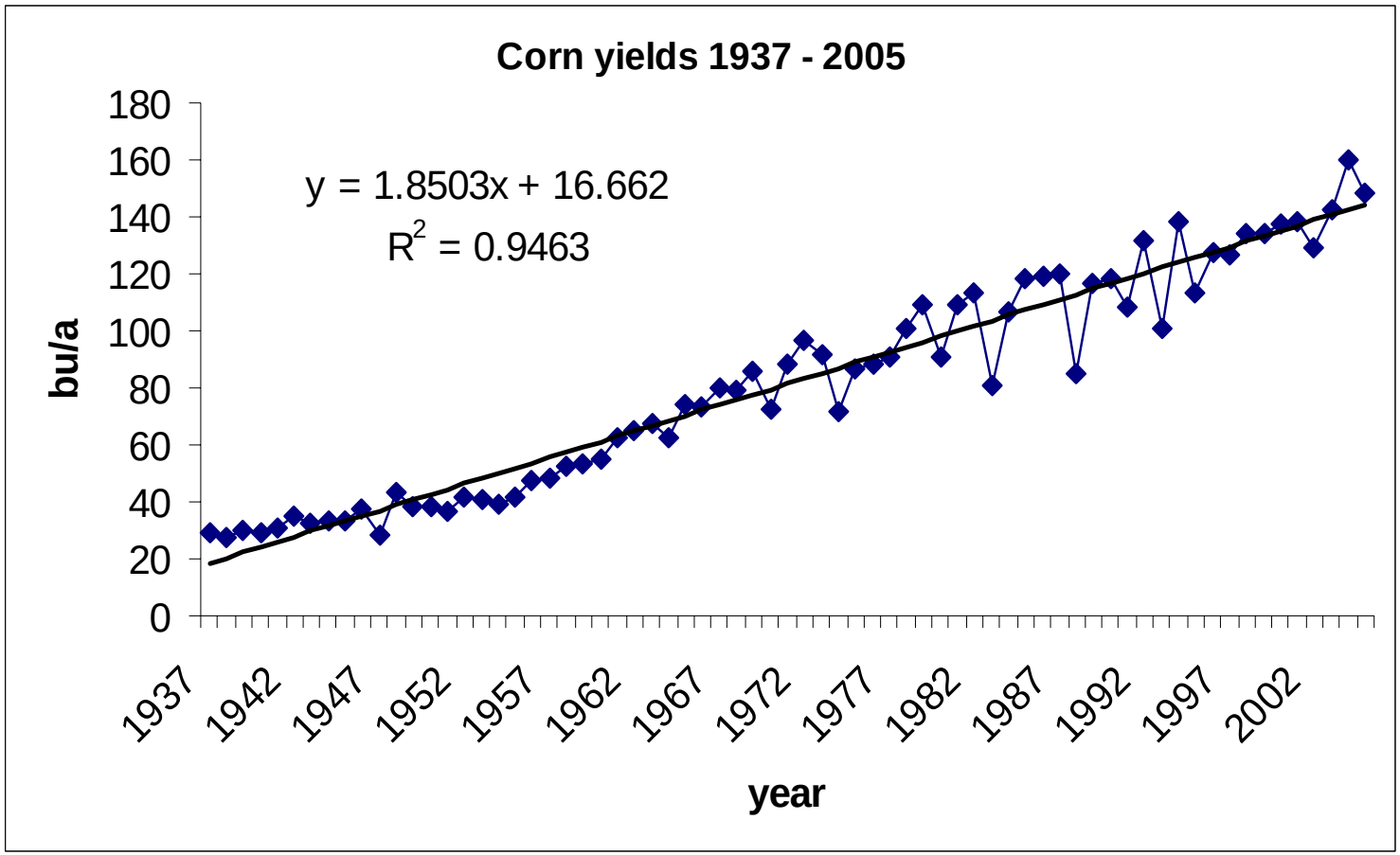

Per cent yield increase of 11 major crops
1868-1998
%
400
350
300
250
200
150
100
50
0
1868
1877
1886
1895
1904
1913
1922
1931
1940
1949
1958
1967
1976
1985
1994
Year

Recent past

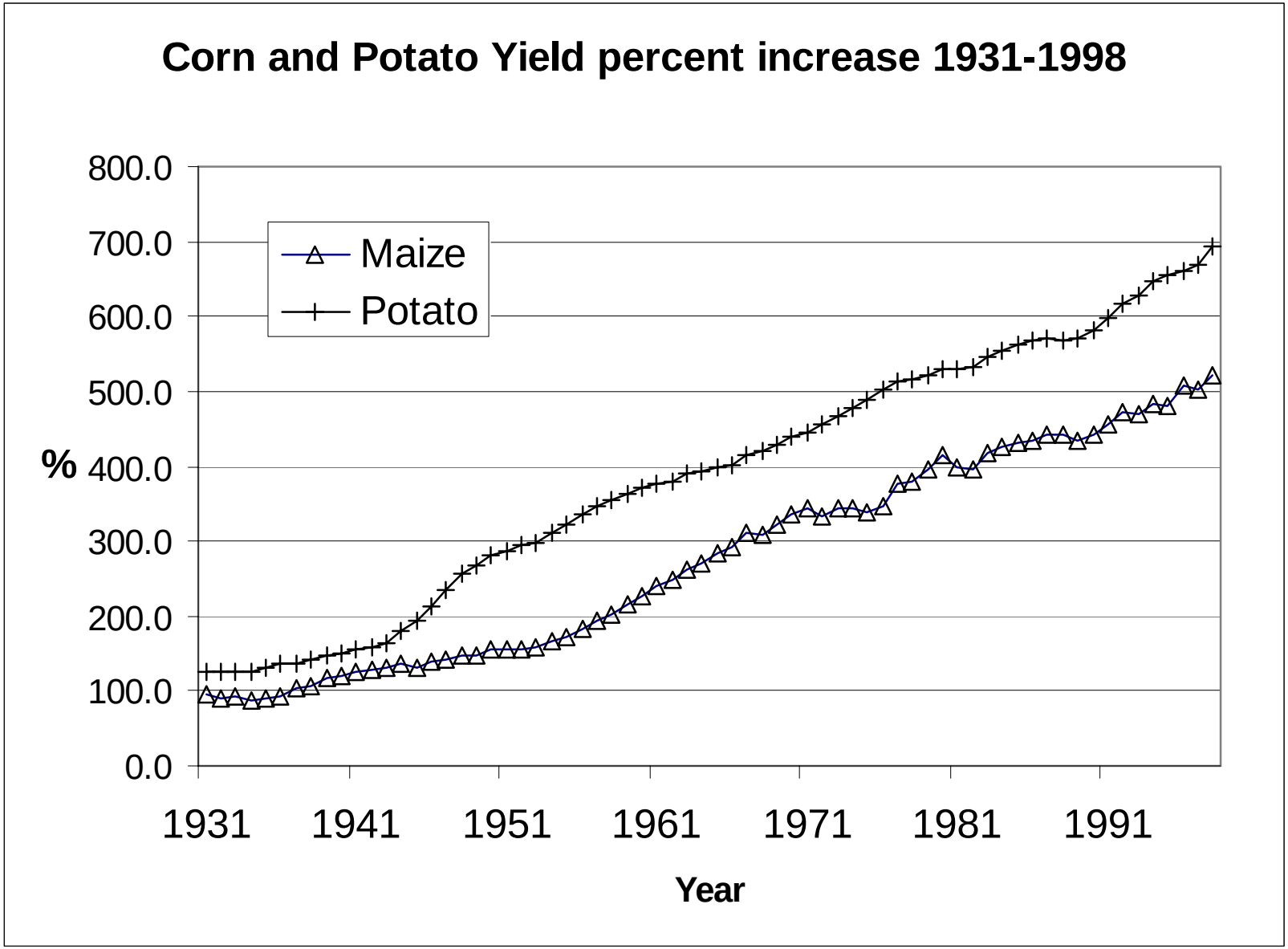


- Corn shows
- Ear to row selection (no replication)

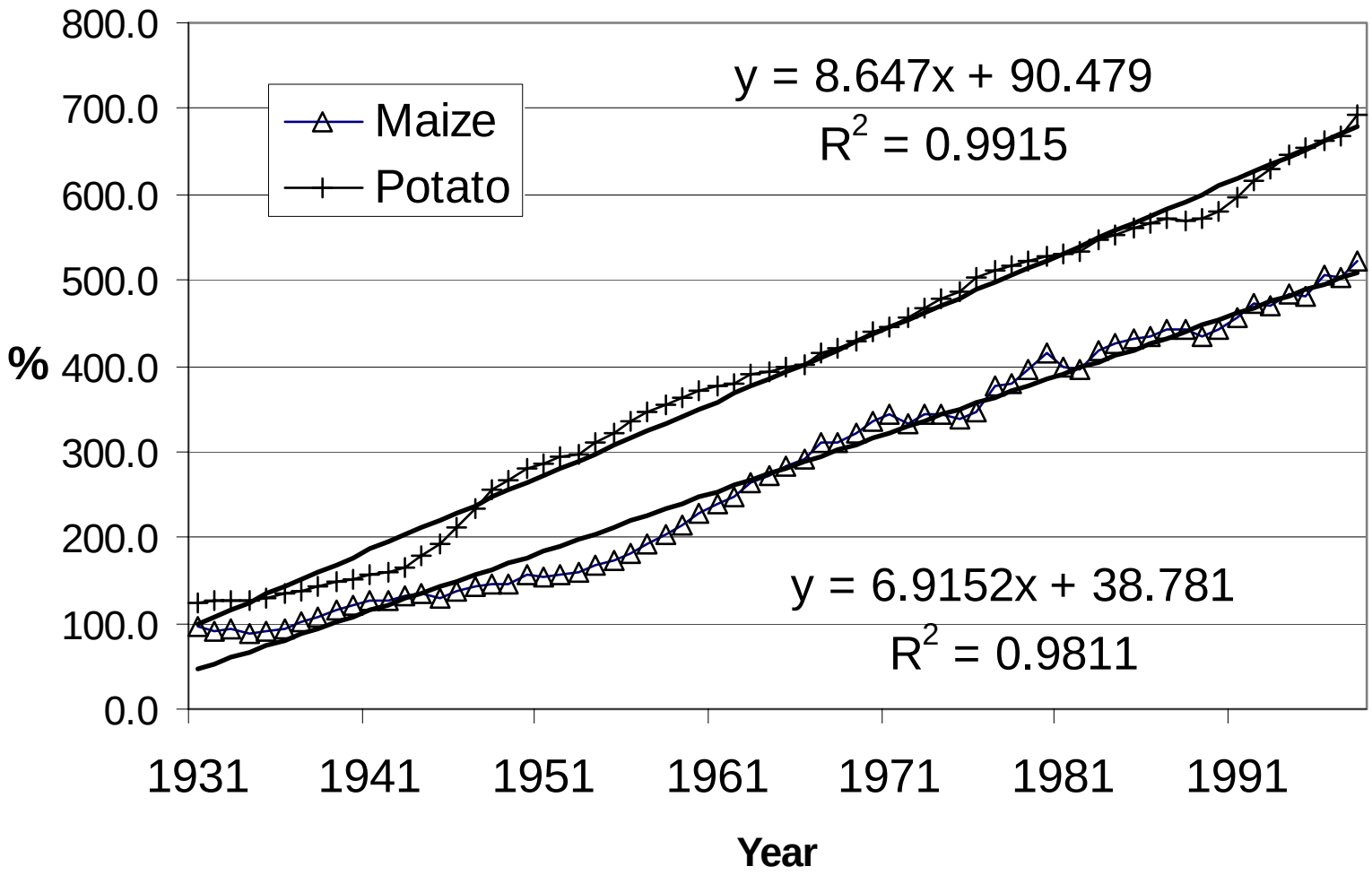
Recent and Current



- Hybrid corn breeding, genetics, statistics
- Intense selection for performance at high plant populations

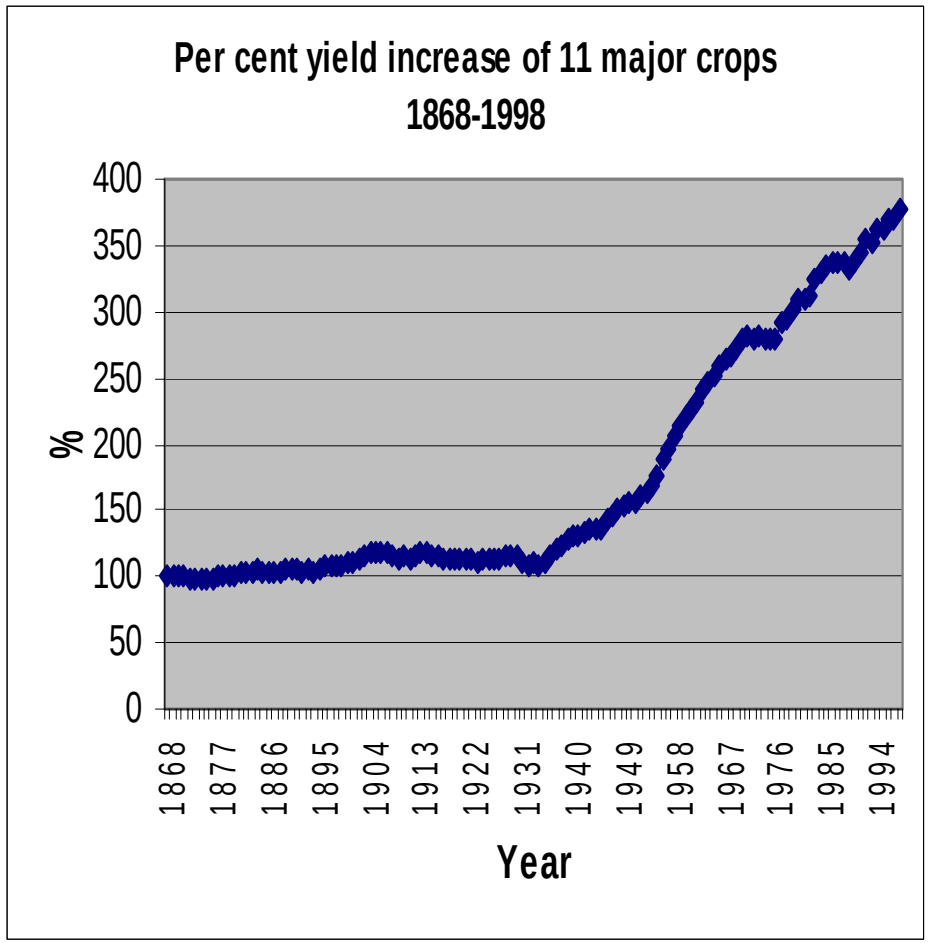

Corn and Potato Yield percent increase 1931-1998
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
%
Maize
Potato
1931
1941
1951
1961
1971
1981
1991
Year

Corn and Potato Yield percent increase 1931-1998



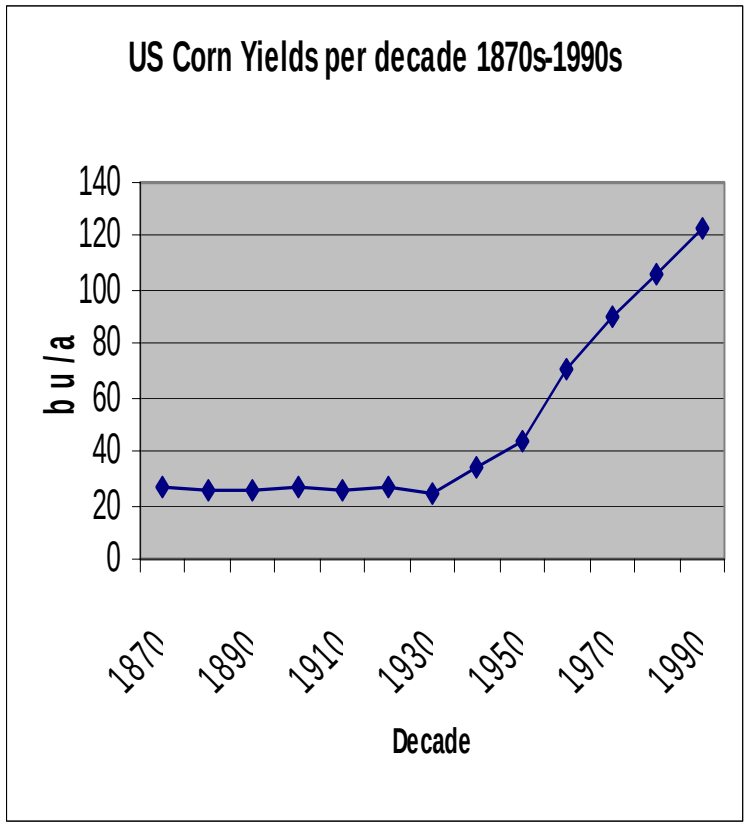
What are the causes of gains in crop yields?

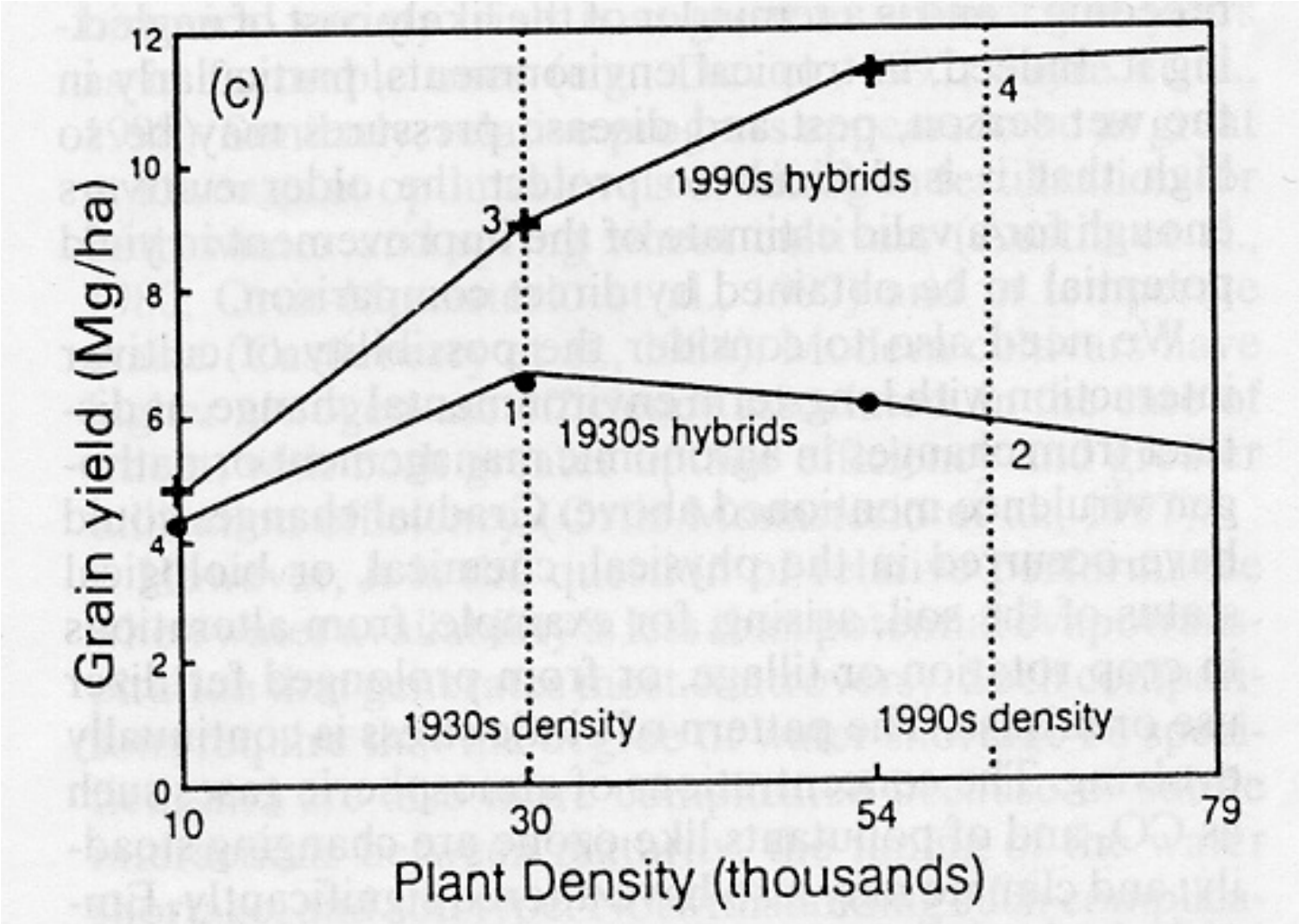
- Genetics
- Management
- Environment -?
  - Elevated CO_2



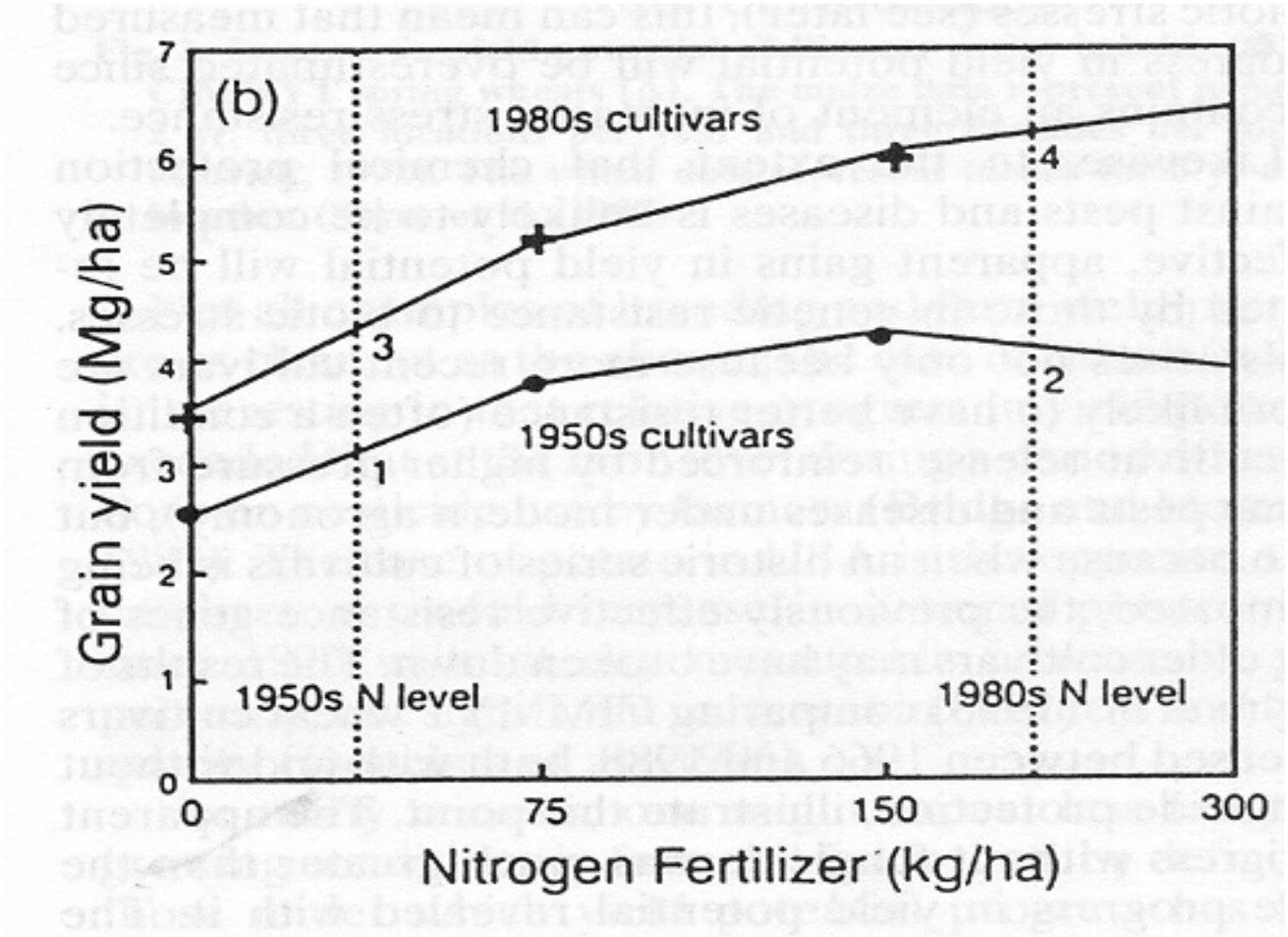
Corn – genetics and management

- Corn - many studies
  - Castelberry et al
  - Duvick
  - Russell
  - others
- Corn 50% - genetic (30-70%)





Evans and Fisher, Crop Sci. 1999

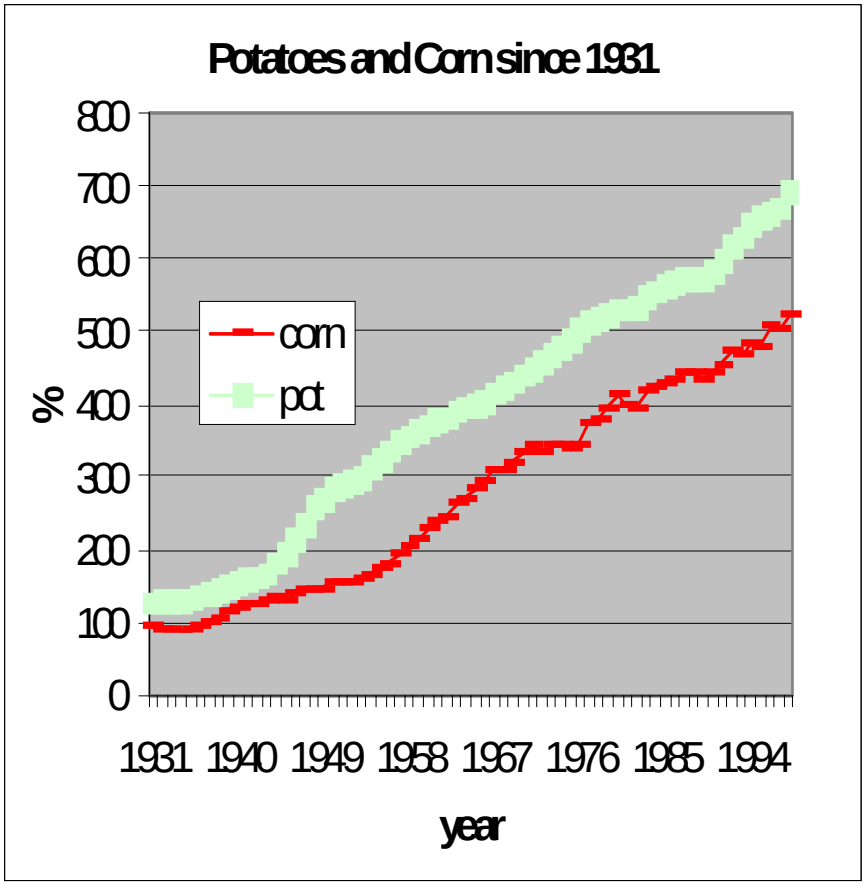


Evans and Fischer, Crop Sci. 1999

Genetic changes in corn since the 1930s

- Stress resistance due to selection at high densities
- Improved stalk and root quality
- Pest resistance
- Modified leaf angle, smaller tassels.

Potato – mainly management

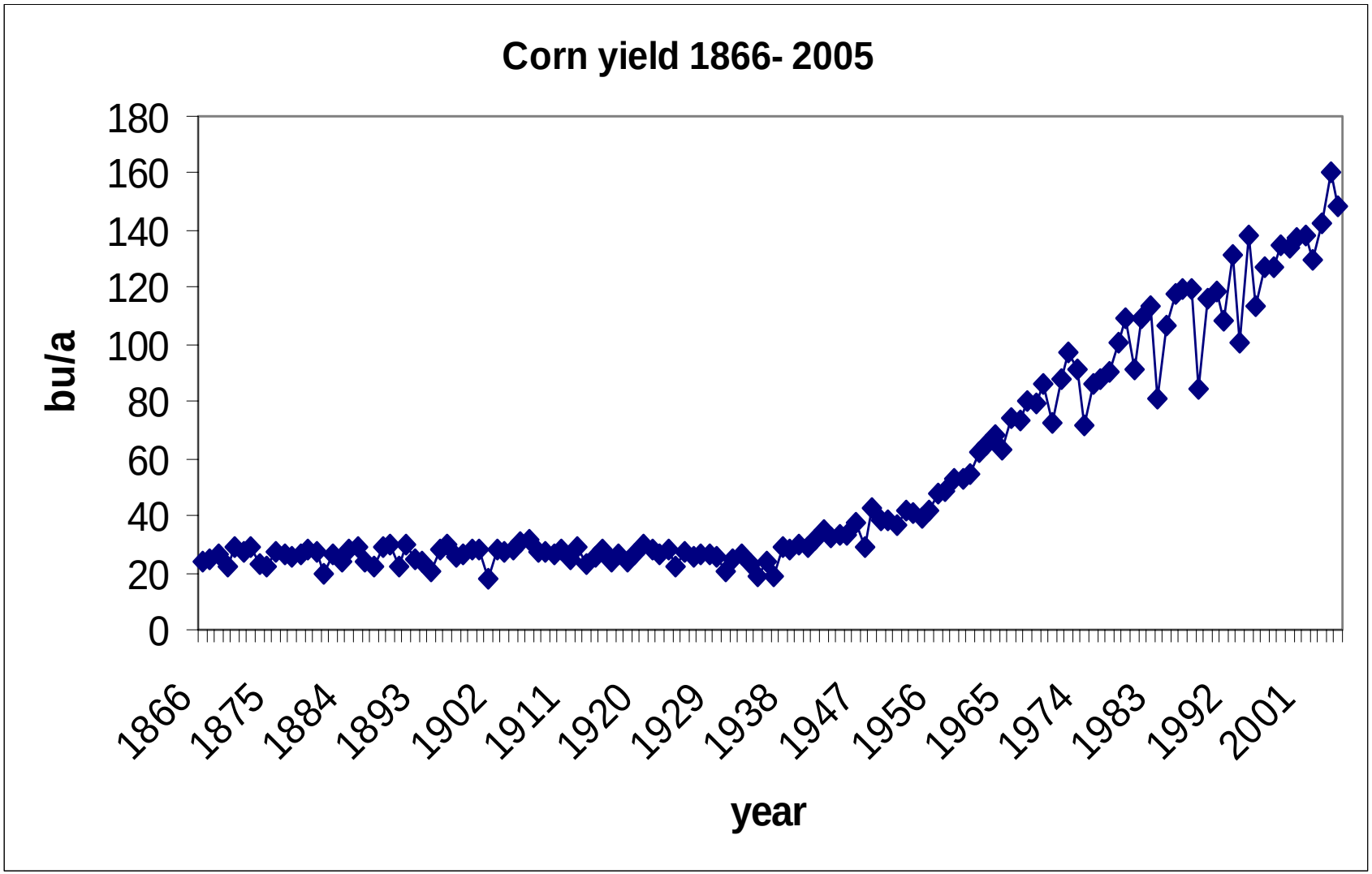


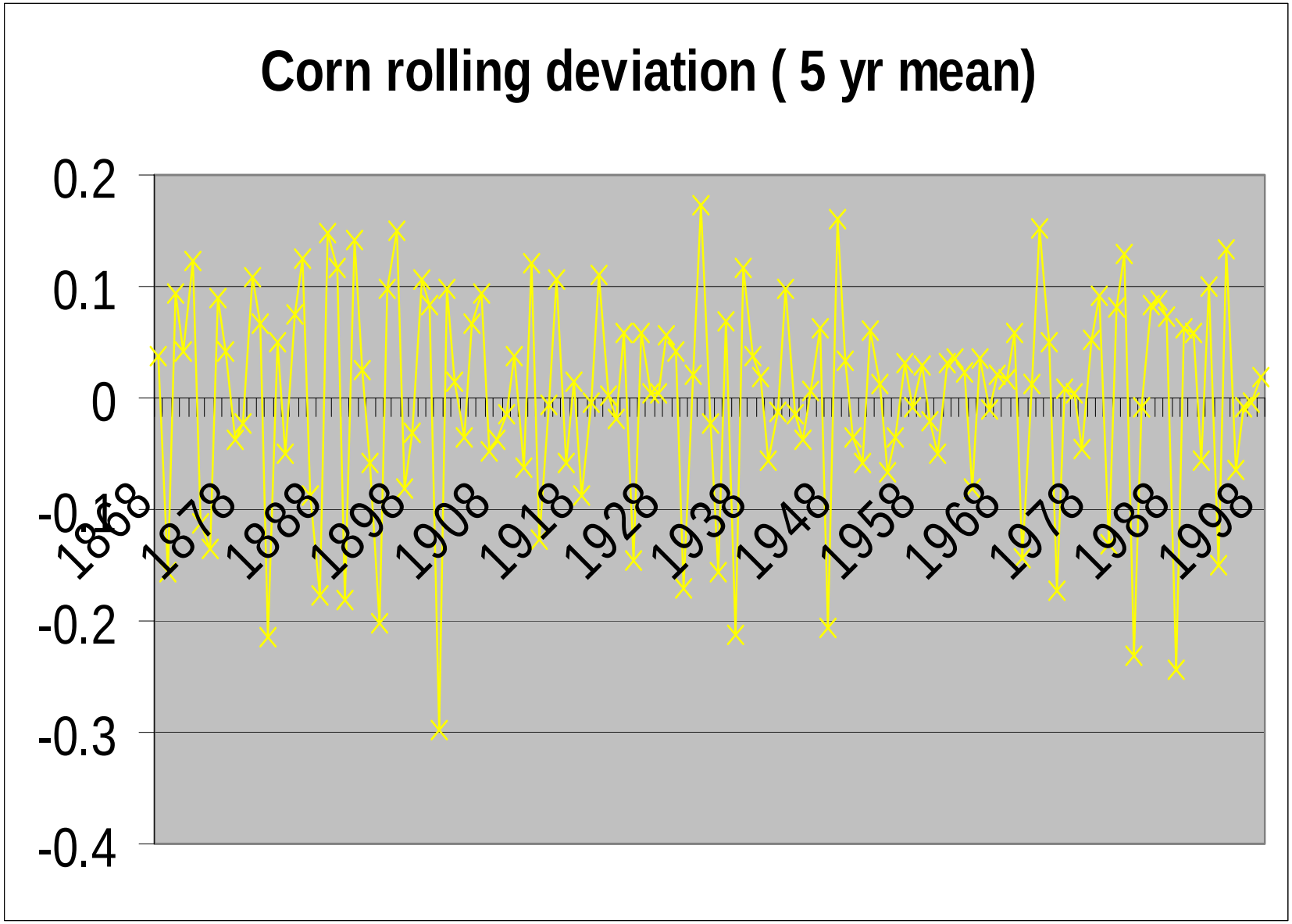
- Very old varieties still important
- Yield increases not due to selection. (Douches et al 1996)
- Selection has emphasized
  - Earliness
  - Quality
  - Pest resistance

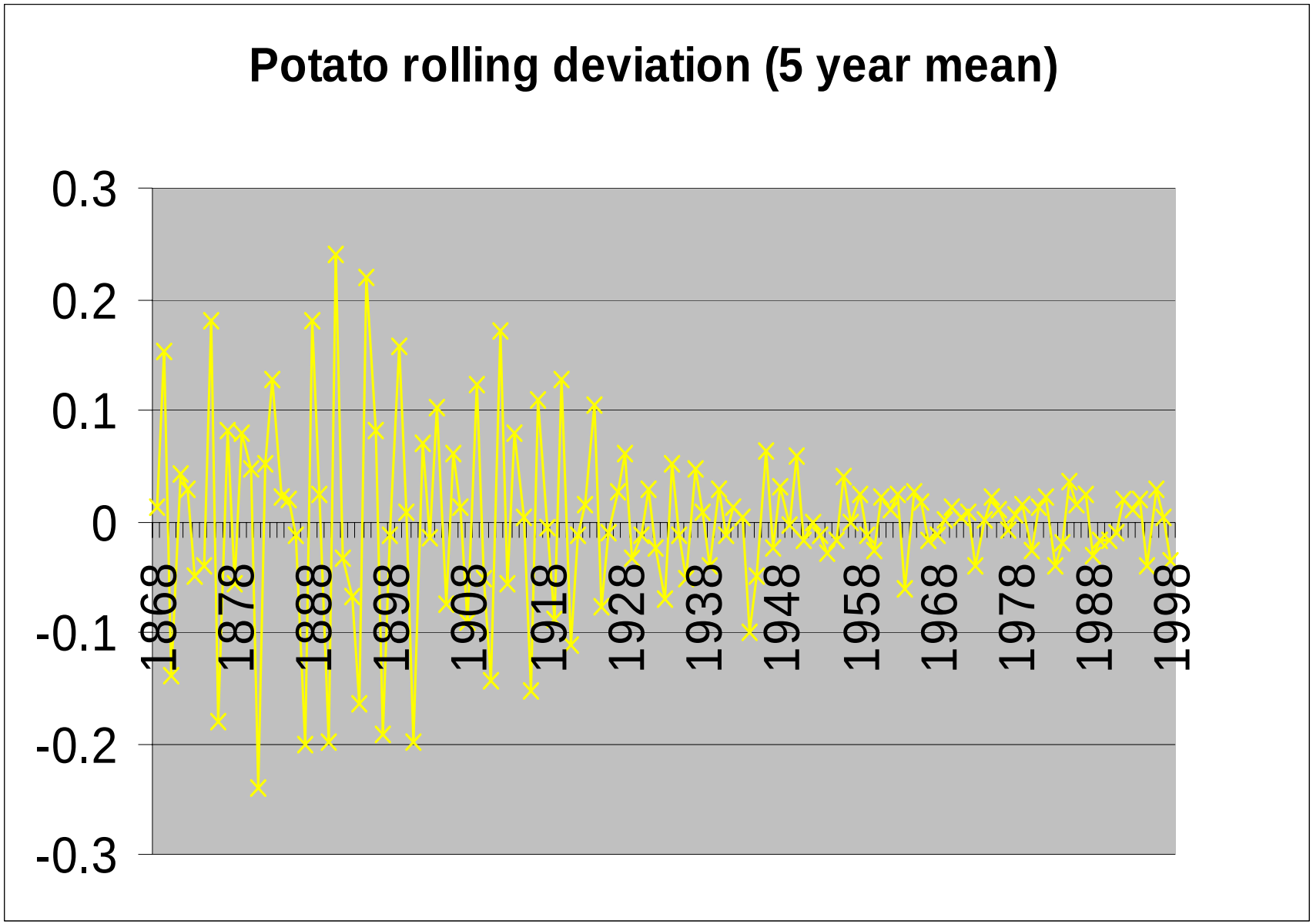
Management

- Irrigation
- Mineral Nutrition
- Spacing and population
- Pest management
- Increased precision of equipment

Has Variation in Productivity Increased Over Time?




Corn rolling deviation (5 yr mean)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
1868
1878
1888
1898
1908
1918
1928
1938
1948
1958
1968
1978
1988
1998


Potato rolling deviation (5 year mean)
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1868
1878
1888
1898
1908
1918
1928
1938
1948
1958
1968
1978
1988
1998

Present - Future

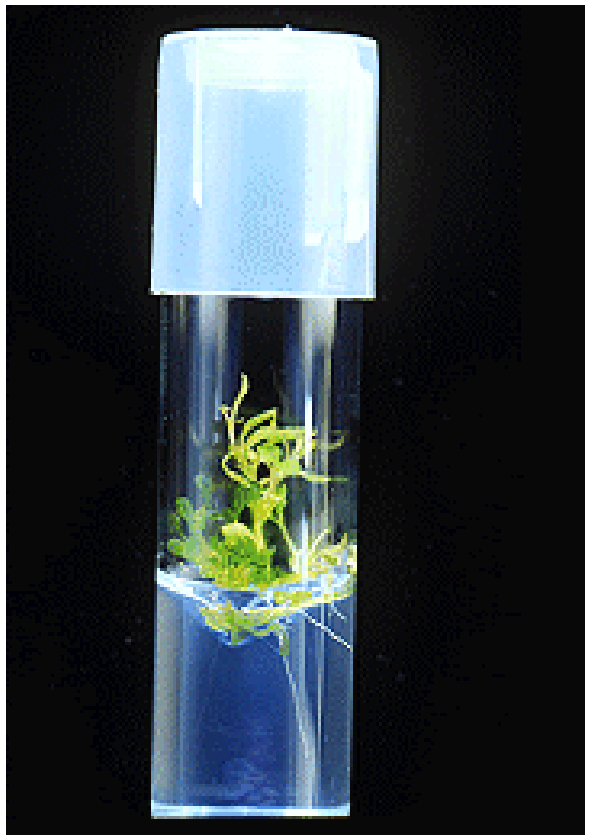
- Genetic Engineering
  - Transformation
  - Traits
- Genomics
  - Using molecular data and tools to make decisions about breeding and designing new plants
- Plant breeding
  - Decisions using genomics and driven by market demand for traits

Present - Future

- Plant protection and production traits
  - Insect resistance
  - Disease resistance
  - Herbicide resistance
- Some consumer traits
  - Altered protein, oil, carbohydrate profiles
- Future
  - *Drought tolerance*
  - *More consumer traits?*

Present - Future

- Consolidation of breeding companies
- Concentration of germplasm ownership
- Driven by research costs
  - 1930-1995 $3 billion
  - 1995-2000 $1 billion
- Customer demand for traits

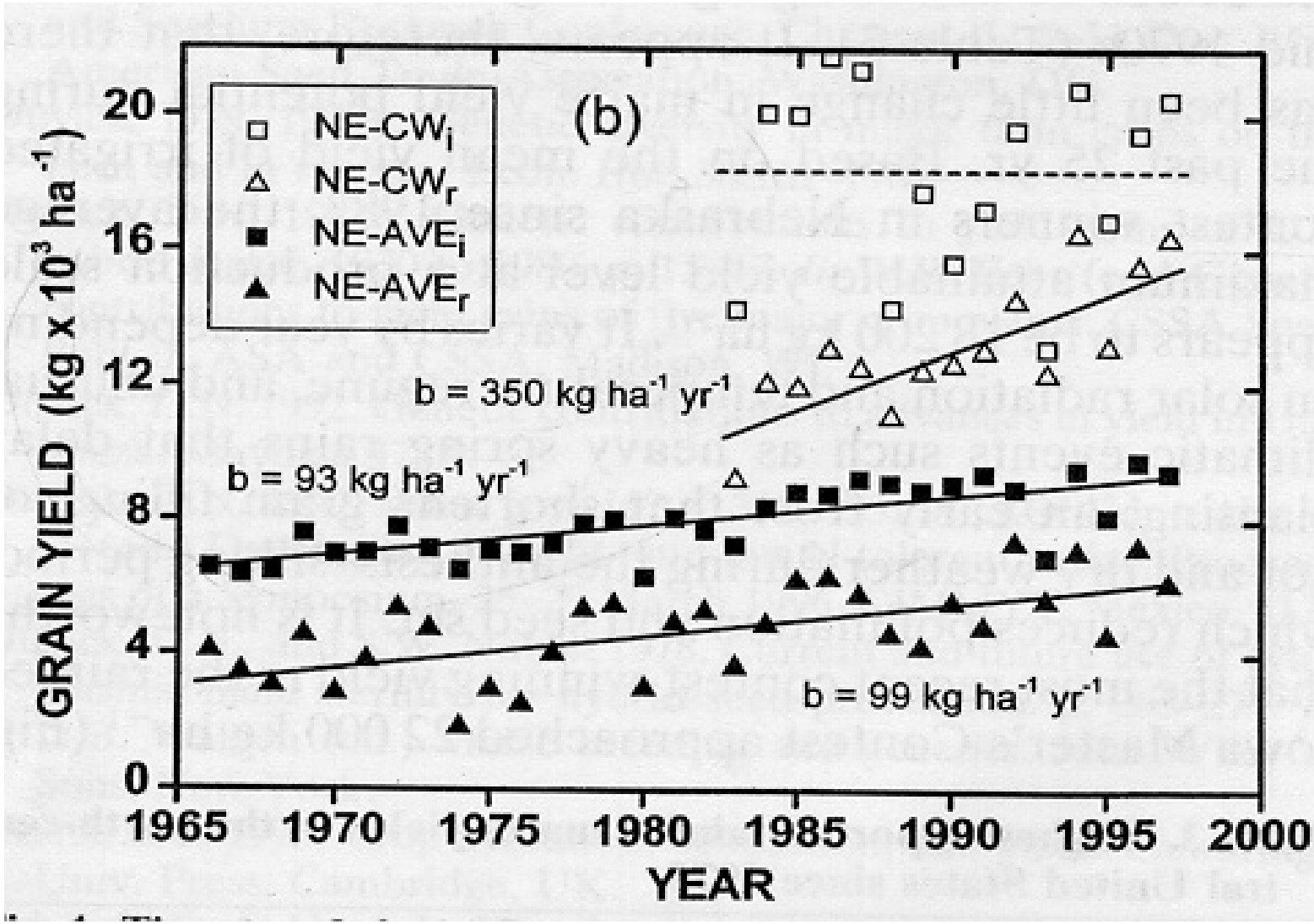


Yield potential

Maximum yield in area of adaptation under best management practices and free of stress.

Yield potential has not increased in most crops

Yields from Nebraska average and contest winners, irrigated and non irrigated

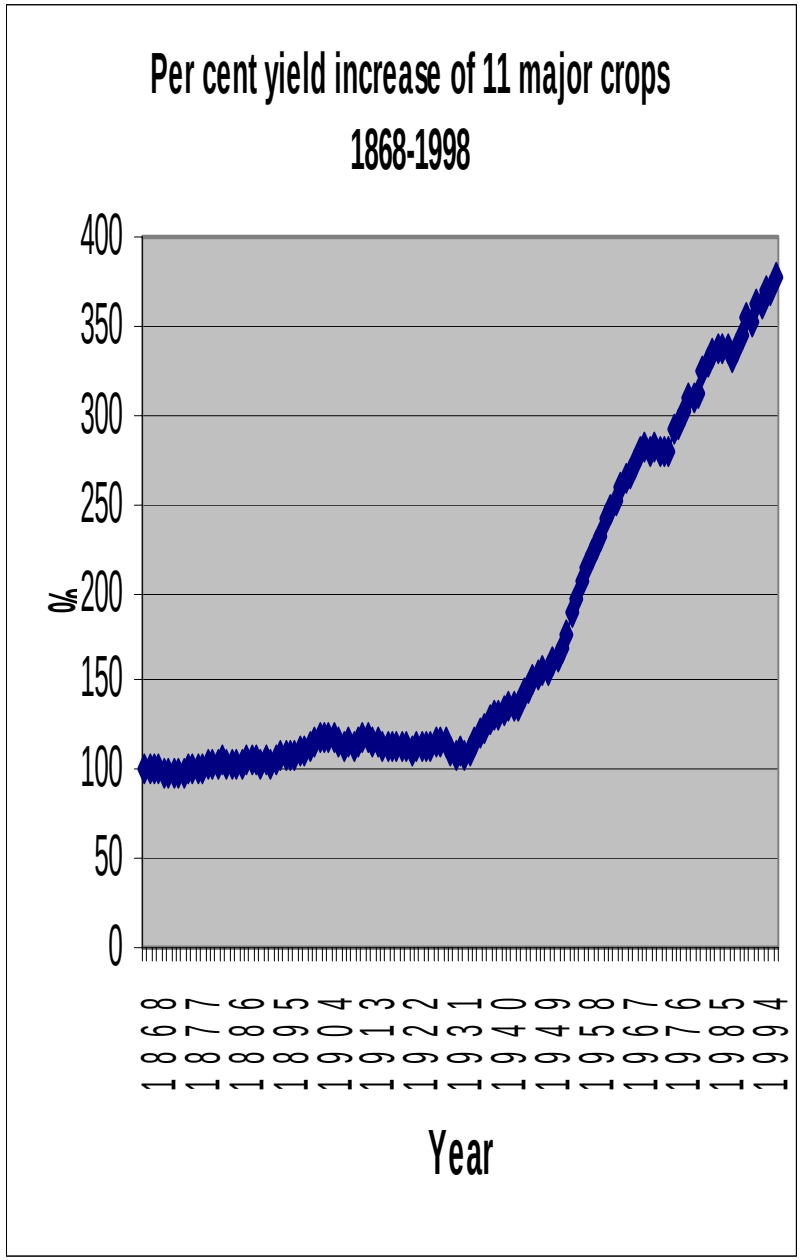


Duvick and Cassman, Crop Sci. 1999

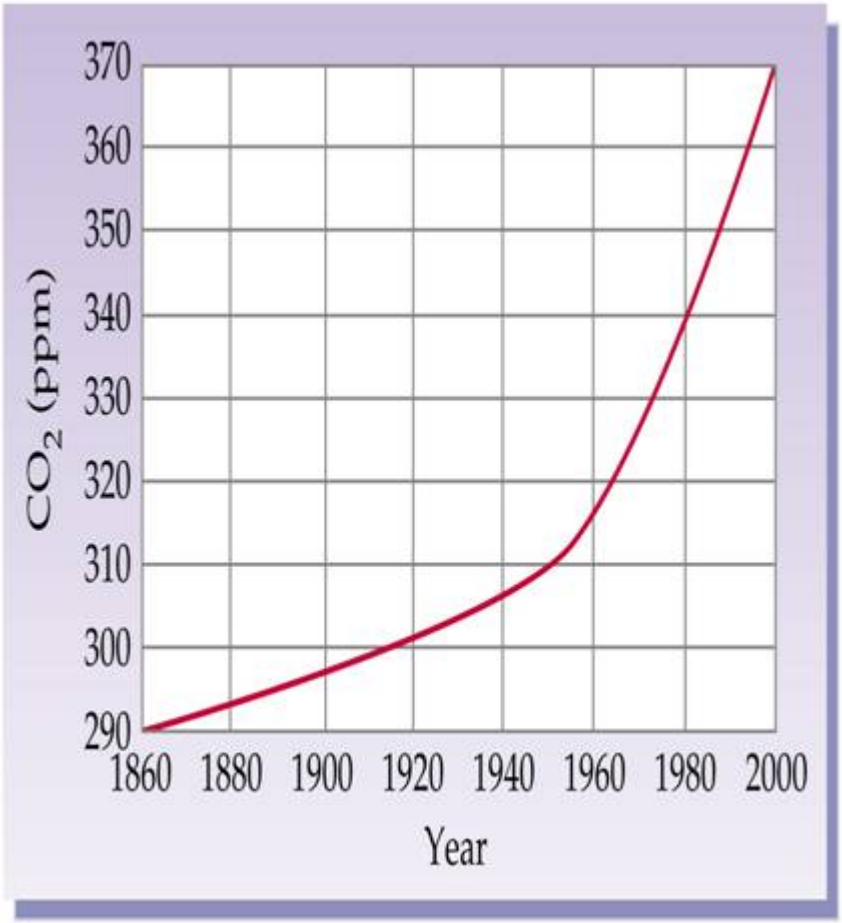
Future questions?

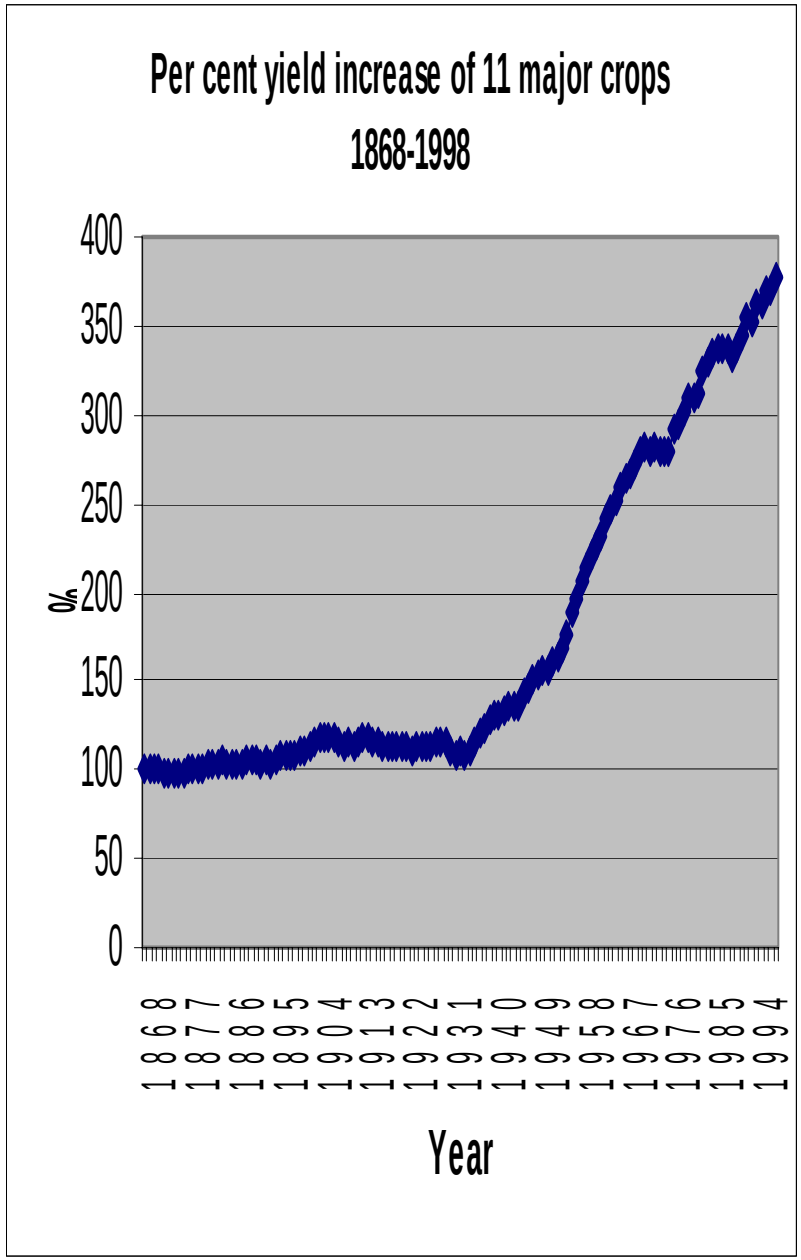
- Emphasis on traits will help reduce stress and help us reach yield potential
  - But will it detract from increasing potential?
- Can genomics be used to increase yield potential?

Food for thought?



CO_2?


370
360
350
340
330
320
310
300
290
CO2 (ppm)
1860
1880
1900
1920
1940
1960
1980
2000
Year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